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PUGH-ROBERTS ASSOCIATES INC CAMBRIDGE MA
NOTES FOR THE APPLICATION OF THE MISSILE O&S COST MODEL.(U)
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NOTES FOR THE APPLICATION

OF THE

MISSILE O&S COST MODEL

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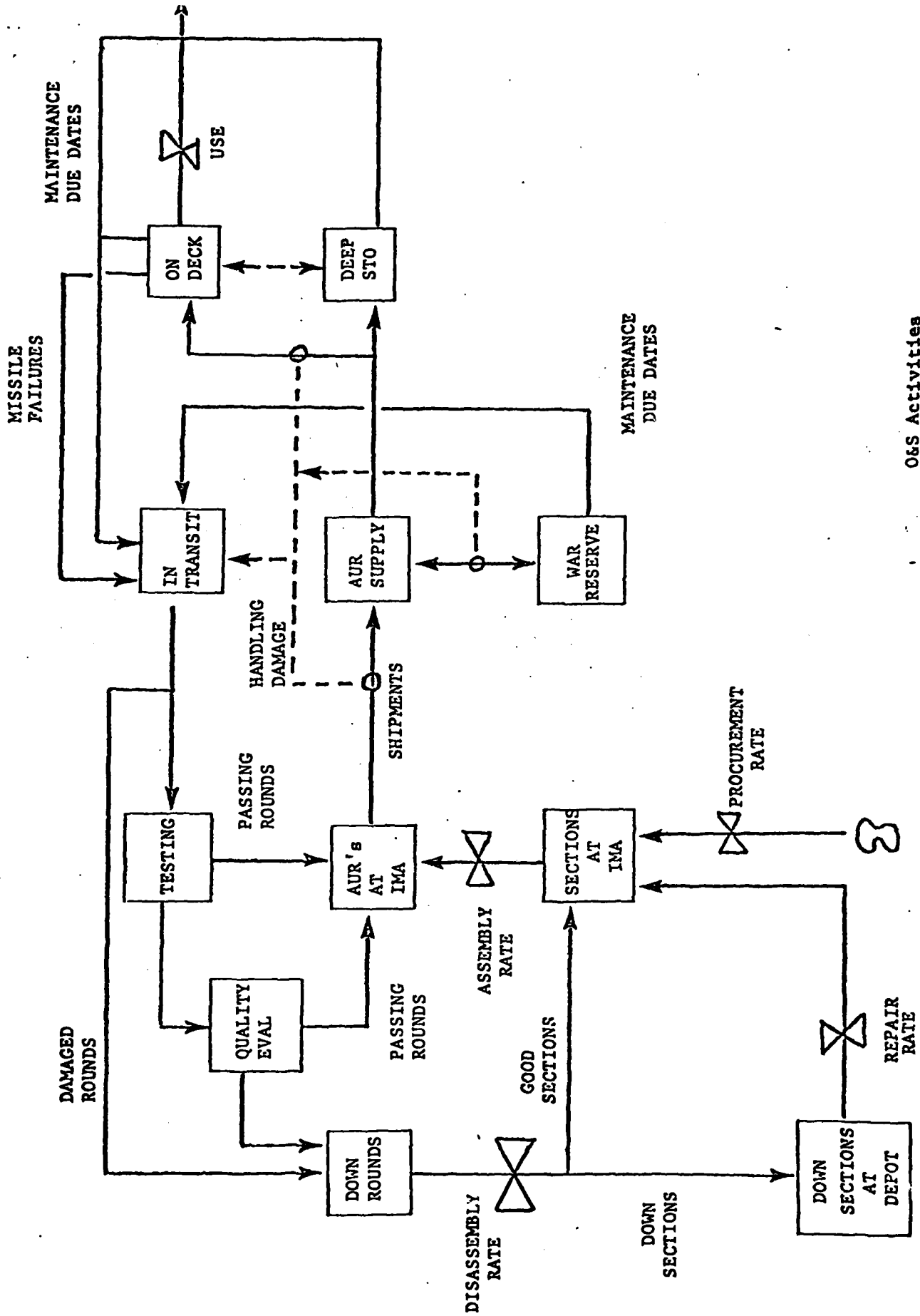
O&S COST RELATIONSHIPS CONTAINED WITHIN THE
MODEL

INPUTS TO THE O&S COST MODEL

Accession For	
NTIS	<input checked="" type="checkbox"/>
GRA&I	<input type="checkbox"/>
ERIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	<input type="checkbox"/>
<i>file for ltr</i>	
Distribution/	
Availability Codes	
Dist	Avail and/or
	Special
<i>A</i>	

OVERVIEW OF O&S SYSTEM STRUCTURE

REPRESENTED BY THE MODEL



O&S Activities

OVERVIEW OF O&S COST CALCULATIONS

CONTAINED WITHIN THE MODEL

OVERVIEW OF
O&S MODEL CALCULATIONS

Arrival of Repaired Sections

INPUTS

- R&M Characteristics
- O&S Cost Factors
- O&S Policies

from
PROCUREMENT
SECTOR

(C)

Delivery
Schedule

Calculate 1
Sections
Arriving
at IMA

Calculate 2
Assembled
& Shipped
From IMA

Good
Missiles &
Sections

Calculate 3
In Transit

To
Readiness
Calculation

Arrivals
at Org.

(D)

Calculate 4
at Organi-
zational Level

Calculate # 5
Used in Firings,
Missile Failures,
Handling Damage,
Fleet Returns

Arrivals at IMA

Calculate IMA 6
Maintenance
Backlog

Calculate # 7
Inspected, Dis-
assembled, Sent
to Depot, Main-
tenance Delays

Arrivals
at Depot

Calculate 8
Depot Main-
tenance
Backlog

Calculate # 9
Missile Sec-
tions & Repar-
ables Repaired,
Maintenance De-
lays

Calculate 10
and Sum O&S
Costs by
Category &
Escalate for
Inflation

Constant-\$
or
Escalated
Output?

Both

Esc.

Constant

O&S Costs

O&S Costs

O&S Costs

O&S MODEL CALCULATIONS

READINESS MEASURES GENERATED

BY THE MODEL

READINESS MEASURES

● NUMERICAL READINESS

Number of all-up rounds (AUR's) available for operations, not undergoing maintenance or in transit to maintenance facilities

● PERCENTAGE READINESS

$$= \frac{\text{"Ready" AUR's}}{\text{Rounds in System}}$$

Rounds in system include the rounds and missile sections undergoing maintenance and in transit to maintenance facilities

● LIKELY READINESS

$$= \text{Numerical Readiness} \quad \times \quad \text{Likelihood of Successful Checkout}$$

$$\begin{aligned} \text{Likelihood of Successful Checkout} &= (1 - \text{Handling Damage Rate}) \times \\ &\quad (1 - \text{Shelf Life Failure Rate}) \times \\ &\quad (1 - \text{Aircraft Avionics/BIT "No-Go" Indication Rate}) \end{aligned}$$

● PERCENTATE LIKELY READINESS

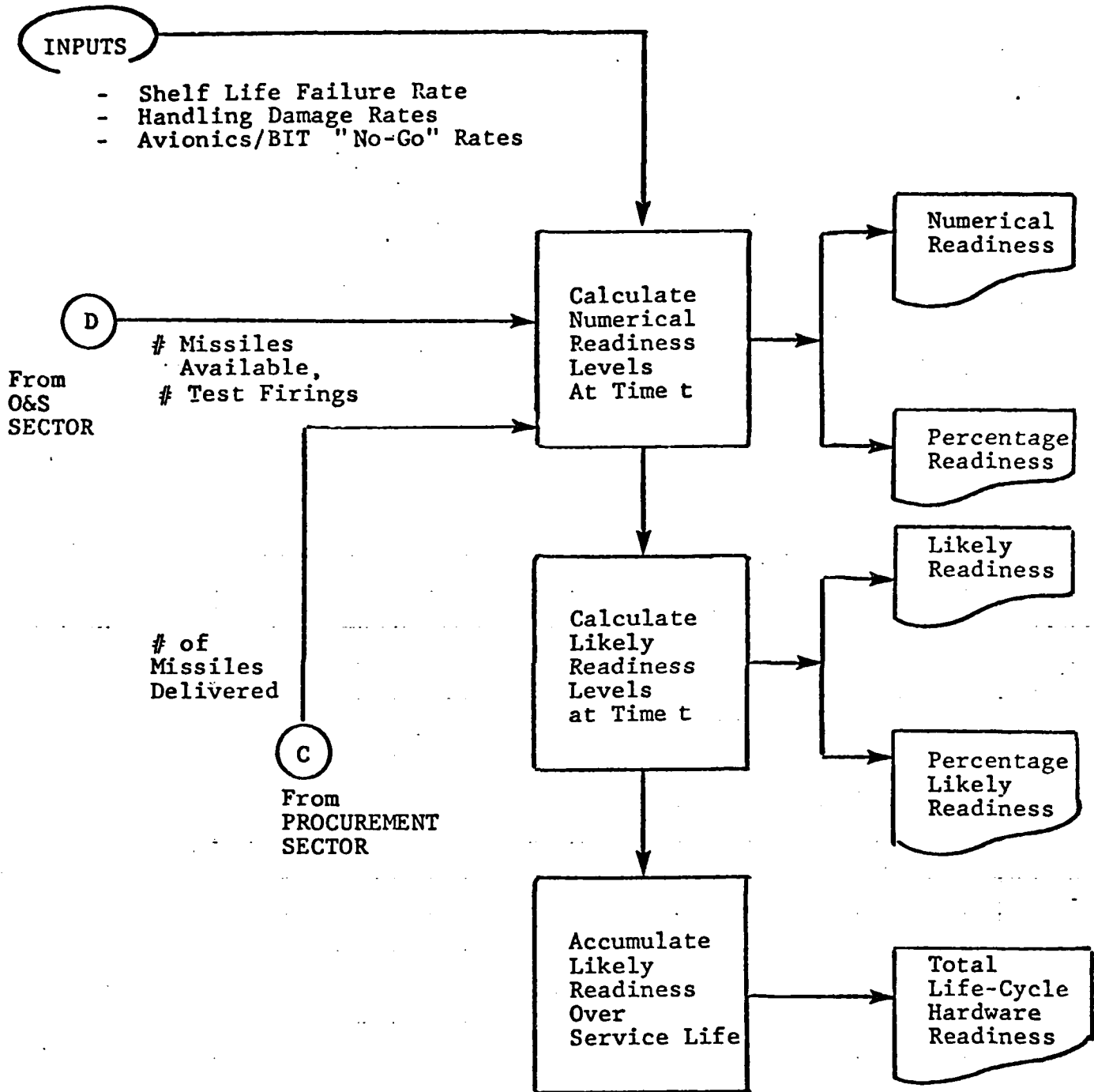
$$= \frac{\text{"Likely Ready" AUR's}}{\text{Rounds in System}}$$

● TOTAL LIFE-CYCLE HARDWARE READINESS

Cumulative number of AUR's "Likely to be Ready" over program life cycle

Dimensions of "Ready Missile-Years"

$$1 \text{ AUR} \times 1 \text{ Year} = 1 \text{ Missile-Year}$$



Readiness Calculation

O&S COST ELEMENTS GENERATED
BY THE MODEL

O&S COST ELEMENTS

<u>COST ELEMENT</u>	<u>BUDGET APPROPRIATION</u>			<u>VARIABLE</u>
	<u>MPN</u>	<u>O&MN</u>	<u>WPN</u>	<u>NAME</u>
HANDLING AND INSPECTION	X			C1
OPERATIONAL TRAINING	X	X		C2
INTERMEDIATE MAINTENANCE	X	X		C4
DEPOT MAINTENANCE	X	X		C6
SUPPLY SUPPORT		X		C7
QUALITY EVALUATION		X		C11
SECOND DESTINATION TRANSPORTATION		X		C14
RECEIPT, SEGREGATION, STORAGE, AND ISSUES (RSSI)		X		C15
REPLACEMENT TRAINING	X	X		C16
REPLENISHMENT SPARES			X	C17

O&S COST RELATIONSHIPS CONTAINED

WITHIN THE MODEL

O&S COST RELATIONSHIPS

<u>COST ELEMENT</u>	<u>CALCULATION</u>
Handling and Inspection	(Number of Men) x (Cost per Man per Year)
Operational Training	(Number of Training Firings) x (Cost per Firing)
IMA Maintenance:	
Maintenance Assembly Labor	(Number of Missiles Assembled) x (Manhours per Assembly) x (Cost per Manhour)
Missile Testing Labor	(Number of Missiles Tested) x (Manhours per Test) x (Cost per Manhour)
Missile Disassembly Labor	(Number of Missiles Disassembled) x (Manhours per Disassembly) x (Cost per Manhour)
Consumable Materials	(Assemblies) x (Consumables Usage) + (Tests) x (Consumables Usage) + (Disassemblies) x (Consumables Usage)
Overhead	(Total IMA Labor Costs) x (IMA Overhead Rate)
Depot Maintenance:	
Missile Section Repair Labor	(Number of Sections Repaired) x (Manhours per Repair) x (Cost per Manhour)
Reparables Repair	(Number of Reparables Repaired) x (Manhours per Repair) x (Cost per Manhour)
Consumable Materials	(Sections Repaired) x (Consumables Usage) + (Reparables Repaired) x (Consumables Usage)
Overhead	(Total Depot Labor Costs) x (Depot Overhead Rate)

O&S COST RELATIONSHIPS

(continued)

<u>COST ELEMENT</u>	<u>CALCULATIONS</u>
Supply Support	(Total Consumables Used) x (% of Consumables Costs) + (Replenishment Spares Cost) x (% of Repairables Costs)
Quality Evaluation:	
Labor	(Number of Missiles Evaluated) x (Manhours per Evaluation) x (Cost per IMA Manhour)
Consumable Materials	(Number of Missiles Evaluated) x (Consumables Usage)
Overhead	(Quality Evaluation Labor Cost) x (IMA Overhead Rate)
Transportation	(Sections to and From Depot) x (Containerized Weight) x (Distance Shipped) x (Cost per Ton-Mile)
RSSI	(Rounds to and From IMA) x (Containerized Weight) x (Cost per Ton)
Replacement Training	(Manpower Level) x (Cost Per Man) ÷ (Average Turnover Time)
Replenishment Spares	(Number of Repairables Used) x (Average Cost per Repairables)

INPUTS TO
THE O&S COST MODEL

INPUTS TO THE O&S COST MODEL

<u>DEFINITION OF VARIABLE</u>	<u>VARIABLE</u>		<u>ILLUSTRATIVE VALUE</u>
	<u>TYPE</u>	<u>NAME</u>	
Desired Number of AUR's "On Deck" from 1980 to 1986, 2-year intervals	T	TDODOT	0/80/140/200 per year
Desired Number of Training Firings from 1980 to 1986, 2-year intervals	T	DUROT	0/16/28/40 per year
Desired Firings per Organizational Unit	C	DUROR	2 per year
Switch, 1="Rotation" Policy 0=Fly Until Die	C	SWRO	0
Time "On Deck", when rotated	C	TODD	0.5 years
Tests per AUR "On Deck"	C	ATYO	2 per year
Normal Handling Damage Fraction	C	NHD	0.02 per move
Normal Indicated Missile Failure Rate	C	FRN	0.1 per BIT/ avionics test
Ratio of Indicated Missile Failures to Number of Actual Failures	C	MAFR	2
Shelf Life Failure Rate, "On Deck" and Deep Storage from 0 to 4 years, 0.5 year intervals	T T	ASL1OT ASL20T	0/.012/.025/.038/.05/.068/ .074/.086/.098
Shelf Life Failure Rate, in Reserve from 0 to 10 years, 1-year intervals	T	FSLRT	0/.021/.041/.061/.081/.1/ .119/.137/.155/.173/.19
Maintenance Due Dates			
Organizational "On Deck"	C	MDODO	2 years
Organizational Deep Storage	C	MDDSO	2 years
Reserve Deep Storage	C	MDRES	5 years

INPUTS TO THE O&S COST MODEL
(continued)

<u>DEFINITION OF VARIABLE</u>	<u>VARIABLE</u>		<u>ILLUSTRATIVE VALUE</u>
	<u>TYPE</u>	<u>NAME</u>	
Organizational Storage Capacity	C	CAPON	2000 missiles
Fraction Kept "On Deck"	C	ODOF	0.1
Shipment Capacity	C	CAPMN	1E6 missiles per year
Shipment Time, to Fleet	C	FWDTT	0.06 years
IMA Shipping & Handling Delay	C	IMAST	0.06 years
Inventory Coverage (Ratio of Stock to Use Rate), Missile Sections at IMA	C	AUSIT	0.06 years
Time to Test at IMA	C	IMATT	0.06 years
Time to Perform Quality Evaluation	C	IMAQT	0.06 years
Time to Disassemble at IMA	C	IMADT	0.06 years
Fraction of Missiles sent to IMA due to BIT/Avionics Indicators which Pass IMA Tests	C	TPFB	0.5
Fraction of Passing BIT/Avionics Missiles which are sent to Quality Evaluation	C	PBFQE	1.0
Ratio of Actual Missile Failures to Number of Indicated Failures among Fleet Returns	C	ATFR	0.5
Fraction of Passing Fleet Returns which are sent to Quality Evaluation	C	PSFQE	0.1
Labor Requirements per Missile At IMA			
Assembly	C	M1	16 manhours
Testing	C	M2	24 manhours
Quality Evaluation	C	MQ	24 manhours
Disassembly	C	M3	16 manhours

INPUTS TO THE O&S COST MODEL
(continued)

<u>DEFINITION OF VARIABLE</u>	<u>VARIABLE</u>		<u>ILLUSTRATIVE VALUE</u>
	<u>TYPE</u>	<u>NAME</u>	
Average Available Consumables Delay, IMA & Depot	C	AVDTI	0.06 years
	C	AVDTD	0.06 years
Fraction Consumables Available	C	CSAV	0.85
Unavailable Consumables Delay, IMA & Depot	C	CXDTI	0.25 years
	C	CXDTD	0.25 years
Shipment Time, to Depot	C	REARTT	0.06 years
Section and Repairables Repair Times, at Depot	C	SREPT	0.06 years
	C	PREPT	0.06 years
Inventory Coverage (Ratio of Stock to Use Rate), Repairables at Depot	C	PCOVT	0.06 years
Needed Repairables per Section	C	NPS	1
Fraction of Repairables Not Economically Repairable	C	FPX	0.2
Labor Requirements at Depot	C	M4	40 manhours
	C	M5	40 manhours
Available Repairables Delay	C	PACCT	0.06 years
Fraction Repairables Available	C	PSAV	0.85
Unavailable Repairables Delay	C	PXDTD	0.25 years
<u>O&S COST FACTORS</u>			
Cost per Enlisted Man	C	CPEM	10E3 \$ per year
Cost Per Officer	C	CPOF	20E3 \$ per year
Handling Manpower per Unit	C	HMMNO	2 men
Manpower Turnover Time	C	HMMTO	2.5 years
Cost per Training Firing	C	CURUO	5E3 \$
Fraction of Firing Costs to O&MN	C	FC20	0.8

INPUTS TO THE O&S COST MODEL
(continued)

<u>DEFINITION OF VARIABLE</u>	<u>VARIABLE</u>		<u>ILLUSTRATIVE VALUE</u>
	<u>TYPE</u>	<u>NAME</u>	
Fraction of Military Personnel At IMA & Depot	C	MPFI	0.2
	C	MPFD	0
Labor Cost at IMA at Depot	C	CPMH	12 \$ per manhour
	C	CPSMH	16 \$ per manhour
Overhead Rates at IMA & Depot	C	C4OR	1.25
	C	C6OR	1.5
Consumables Usage per Missile In:			
Assembly	C	CON1	50 \$
Testing	C	CON2	50 \$
Disassembly	C	CON3	50 \$
Missile Section Repair	C	CON4	100 \$
Reparables Repair	C	CON5	100 \$
Fraction of Supply Support Costs on Value of Consumables & Reparables	C	C7CR	0.15
	C	C7PR	0.15
Containerized Missile Weight	C	AVMWT	0.4 tons
Containerized Section Weight	C	AVSWT	0.12 tons
Transportation Costs	C	CPMILE	0.10 \$ per ton-mile
Distance Shipped	C	AVRD	3000 miles
RSSI Costs	C	CPRND	74 \$ per ton
Time to Train EM's	C	TTEM	0.28 years
Cost to Train EM's, Other than Pay	C	C16EM	2000 \$
Number of Major Reparables per Missile	C	NPAUR	20

INPUTS TO THE O&S COST MODEL

(continued)

PROCUREMENT/DELIVERY INPUTS

<u>DEFINITION OF VARIABLE</u>	<u>VARIABLE</u>		<u>ILLUSTRATIVE VALUE</u>
	<u>TYPE*</u>	<u>NAME</u>	
Pilot Production Time Span	C	PIT	1 year
Number in Plot Lot	C	PIN	120 missiles
Number of Plot Models Used for T&E	C	RDPIN	40
Production Initiation Time	C	PRITN	1978
Full-Scale Production Time Span	C	PRTT	5 years
First-year (Pilot) Production Lot	C	NUMIT	120 missiles
Total Full-Scale Production Lot	C	NUMT	3000 missiles
Fraction of Full-Scale Lot In:			
Year 1	C	NUM1F	0
Year 2	C	NUM2F	0.12
Year 3	C	NUM3F	0.24
Year 4	C	NUM4F	0.26
Year 5	C	NUM5F	0.20
Year 6	C	NUM6F	0.18
Year 7	C	NUM7F	0
Fraction Cut Back in Stretch-Out	C	PRVDV	0
Date of Initial Cutback	C	PRVDTT	2000
Time Span of Cutback	C	PRDEL	0 years
Initial Delivery Delay	C	PROCD	1 year
Start of Simulation	C	TIMEN	1978

